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The Sources of House Price Change: Identifying Liquidity Shocks to the Housing Market

1.- Introduction

The Global Financial Crisis (GFC) and the ensuing credit crunch has had asymmetric effects across different countries in the world and also within the European Union (EU). Imbalances across the EU have become evident in the years since 2008. The lack of harmonisation in, for example, the fiscal system, financial supervision and differences in state welfare programmes have been well documented. However, some market mechanisms that are central to macroeconomic equilibrium, linking the financial system and real economy at the macro level, have received comparatively less attention. Of these the housing sector is fundamental with many analysts placing housing debt at the origins of the GFC. Indeed, housing imbalances and the operation of the housing market have been at the core of wider macroeconomic imbalances in several European countries. House prices have a direct impact on housing wealth (real or perceived), and hence on consumption and macroeconomic growth. House prices impact on the risk level of financial institutions through the value of collateral for mortgages and real estate assets. House prices also affect monetary policy objectives focusing on inflation targeting, through liquidity channels.

House prices and their impact on macroeconomic equilibrium has been recognized by the European Commission (EC) through the inclusion of house price indices as one of 11 scoreboard indicators chosen as “the most relevant dimensions of macroeconomic imbalances and competitiveness losses” (EU, 2012:4¹). Likewise, the Macroeconomic Imbalance Procedure (MIP) and the Excessive Imbalance Procedure (EIP) identify house price change as the key early warning measure indicating the possibility of macroeconomic imbalance as “... large movements in real asset markets have been traditionally associated with a number of economic crisis.” (EU, 2012:16).

The aim of this paper is to add evidence about the role of liquidity affecting housing prices and how the Asset Inflation Channel transmits its influences on house prices in two countries, Spain and the UK. The selection of both countries is not casual but rather is due to the different monetary frameworks (Euro and sterling) which will impact the monetary policy adopted and the total amount of liquidity. The structure of the paper is as follows. The second section is devoted to the literature, the third section explains the paper’s aim, objectives and the theoretical framework. Section four explains the empirical model, while section five explains the data base used and the econometric exercise. Section 6 presents the results and section 7 includes further discussion and conclusions.

¹ The number of scoreboard indicators were extent to 11 in 2013. European Economy, 2012, ‘Scoreboard for the surveillance of macroeconomic imbalances, Occasional Papers 92, Brussels

2.- Literature

How the GFC transmission occurred across EU countries, its effects, the strength of the credit crunch in different countries and consequences at a social level still raises many questions. While the literature explains how the financial crisis impacted on economies, the Central Banks' reactions to avoid the worst of the effects and the recommended policies there still remains a gap in the knowledge base on how global effects contributed to macroeconomic imbalances. Earlier studies for example, of that by Shiller (2000) focused on how deregulation of the financial system at the global level contributed to large flows of liquidity. Most of the effects of financial liberalisation were transmitted via the banking system, with the increase in liquidity and credit having an impact on both private and public debt. This resulted in high levels of indebtedness of households and firms (Debelle, 2004, Iacoviello and Minetti, 2008). In the case of households, one of the effects of financial liberalisation was an increase in finance flows towards housing and real estate markets, creating the first synchronised global housing cycle (Taylor, 2007, Kim and Renaud, 2009). Indeed, a wealth of recent literature (Mishkin, 2007, Muellbauer, 2008, Iacoviello, 2005) indicates that increases in mortgage credit resulting from monetary policy fuelled housing demand and increased house prices (Bernanke, 2010).

Real variables create an imbalance when they perform out of the long term equilibrium, for example when there is a fall in production, changes in demand (stronger or lower), exports/imports, either at unusually high or low levels, produce international imbalances. Similarly, imbalances occur with strong changes in population mobility and migration flows. Financial or monetary imbalances appear when long term inflation occurs or when financial flows change affecting investment (real). Four groups of factors emerge as being important: (1) real factors with permanent effect for any economy, such as growth/fall in demand due to changes in the domestic demographic structure, income or long term economic growth determine the wealth accumulation process in the economy; (2) financial factors including funds and interest rates, which are both directly determined by the total availability of domestic funds in the economy and by private and public savings, and by the degree of integration in the international financial system allow use of extra savings from other economies. Collectively groups (1) and (2) have long term effects on the economy. (3) Short term variables affecting the macro economy equilibrium, for example movements in interest rates or inflation and (4) shocks occurring in the economy due to unexpected and unforeseeable changes in various economic and social conditions from the third and fourth groups respectively.

When variables relating to demographics, finance or income change, the macroeconomic imbalance is transmitted to the housing market through their effect on the demand side. For owner-occupiers, sudden changes in demand affect house prices generating a second imbalance through various effects due to the large number of interrelationships between house prices and other macroeconomic sectors. If local supply conditions allow the house building response, a rise in prices acts as a trigger for development which increases economic added value, with the consequence that the whole economy grows (Mueller, 1999). On the other hand, an increase in house prices increases household wealth, strengthening the role of

housing as collateral for loans and modifying relative price expectations, with effects on affordability. The strength of change in house prices could serve as an incentive to extra investment in the housing market while a fall in house prices could have the opposite effect.

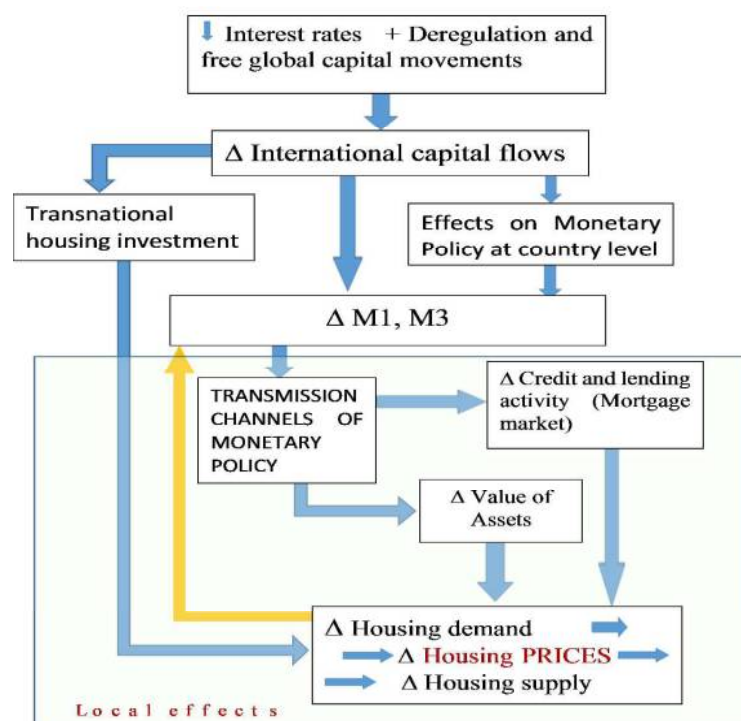
The literature discusses long run equilibrium for housing markets with a particular focus on the short run dynamics of adjustment processes. From a microeconomic perspective, house prices are the result of local short run disequilibrium due to inflexible supply and the difficulty in responding to demand change (DiPasquale and Wheaton, 1994, Ortalo-Magné and Rady, 2006). In reference to the inflexibility of supply (Muellbauer and Murphy, 2008), it means that the housing market equilibrium does not take place in the short run because of the rigidity of the supply curve. Equilibrium is eventually achieved as the curve gradually acquires more flexibility and adjustment takes place (Meen, 2002, Topel & Rosen, 1988, Quigley, 1997, De Leeuw & Ekanem, 1971, Olsen, 1987, Hanushek & Quigley, 1979, Blackley, 1999, Glaeser et al, 2005).

Levitin and Wachter (2013) suggest that housing is unusually susceptible to booms and busts because credit conditions affect demand. Homeownership requires borrowing making the housing market dependent on the credit system. Any imbalance in the credit system is transmitted through an increase/decrease of financial flows to the housing market. Most literature focuses on the credit channel of the monetary transmission framework. Liquidity affects credit generation by fuelling housing demand and thus causing house prices to rise (Lastrapes, 2002, Aron et al, 2010, Goodhart and Hofmann, 2008). As the number of loans increase, the credit multiplier increases liquidity in the economy.

Several studies have investigated the links between monetary policy and housing booms (Mishkin, 1995, 2007, Favero and Giavazzi, 1999) supporting the idea that the credit channel is not the only way to transmit the effect of house price changes. Muellbauer (2007), Setzer et al, (2010) and Greiber and Setzer (2007), find evidence that liquidity contributes to an increase in house prices through three different channels: money demand (Setzer et al 2010, Friedman 1988), Asset inflation (the role of liquidity with respect to housing finance), as well as credit channels. They conclude that housing may act as a catalyst which amplifies the effects of monetary policy reinforcing the relationship between house prices and loans and providing a house price channel. They find that "... collateral or credit channel effects which also imply a positive correlation between money and housing should be significant. This is in line with empirical estimates suggesting that house price fluctuations are a major determinant of credit cycles (ECB 2003)." (Greiber and Setzer, 2007:15).

The essence of this literature is summarised in Figure 1 that distinguishes between capital/monetary flows and financial flows. The former have indirect effects on house prices through channels of monetary transmission while the financial cycle affects housing through direct investment or financing developments.

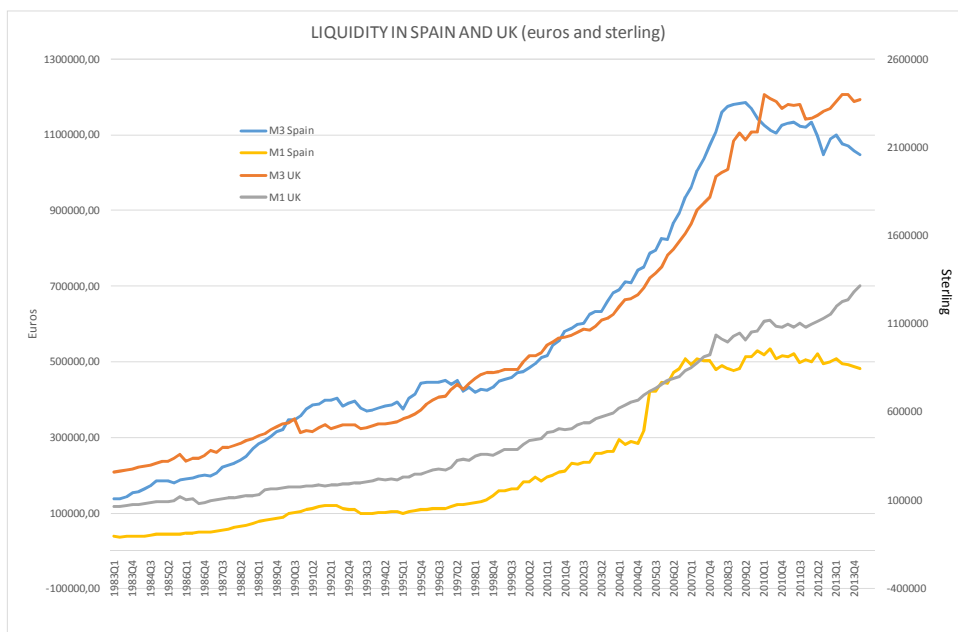
Figure 1: Representation of Housing Market and Financial Market Interlinkages



The figure shows several transmission channels between changes in capital flows and the housing market. On the one hand, an increase in money or credit availability (for instance, coming from high housing market liquidity or savings) in the presence of low interest rates could increase international housing demand. Capital and monetary liquidity flows (with an enlarging interbank market) affect the credit channel and/or the Asset channel with the effect of increasing housing demand through greater mortgage availability or price incentives to invest in housing. On the other hand, the accumulation of demand in the housing market could cause a further increase in total liquidity (for instance, when demanders come from other region or due to the need of cash when credit increases). These create a circle between liquidity and housing demand which could fuel housing supply at different rates. The circle has different effects at local levels and it is possible that the strength of this relationship varies across regions. The described phenomena remains unanalysed.

In Europe, due to successive changes in the financial framework (both international and European), liquidity has increased dramatically in the last two decades. Policies of deregulation in Europe began with the UK in the early 1980s. Subsequent developments in the EU saw monetary union with the creation of the Eurozone with the Euro beginning to circulate in 2001. During this process liquidity increased. Interbank lending increased that fed into economies via capital flows through the banking system. Increases have been identified in monetary aggregates, namely M1 and M3. Figure 2 shows how these changed for both Spain and the United Kingdom.

Figure 2: Evolution of Liquidity (M1 and M3) in Spain and the UK, 1983q1 – 2013q4



The figure clearly shows the increase in both liquidity measures in each country that is almost continual until 2007/8. Also notable is the increasing gap between the monetary measures and the particularly rapid increase in M3 in both countries in the 5 years or more before the GFC.

The European Central Bank (ECB) suggested that most liquidity went into the housing and commercial real estate markets and provided funds for household mortgages putting upward pressure on house prices. Thus a strong and possibly strengthening channel between monetary indicators and house prices could exist. Monetary stimuli could therefore be transmitted to the housing market in many different ways through various channels. Because of this both MIP and EIP see house price change as having a major destabilising impact on macro-economies.

3.- Aim, Objectives and Theoretical framework

In light of the above, the aim of this paper is to examine the role of monetary liquidity in house price evolution through examining the *Asset (housing) Inflation Channel*. In relation to our supporting objectives, we attempt to identify the main channels of transmission affecting house prices testing from monetary supply channels to house price change. We examine the Asset price channel and specifically in this paper we focus on the role of M1 and examine its impact in Spain and the UK. These countries have had significant house price inflation until the start of the GFC. Since then, Spain has witnessed significant reductions in house prices while in the UK, although house prices have fallen, since 2013 prices began to increase across the country and, initially, by significantly more in London.

Monetary policy instruments transmit their influence via, for example, interest rates that in turn impact on liquidity and thus changes in GDP. Financial market deregulation and EMU creation modify the capacity of monetary policy to control inflation. It is also difficult to control M3. With EMU, liquidity increased by more than had been expected, with varying spatial distribution. Researchers have become increasingly interested to know how house price change could impact on monetary aggregates and hence monetary policy.

When considering the channels of monetary policy transmission, money supply change can lead to GDP change thus impacting housing demand and house prices, having the opposite causality to the above. Credit, balance sheet, and Asset Inflation channels may also be considered. For example, Mishkin (2007); Lastrapes (2002); and Weber et al.(2011) examine the credit and balance sheet channels. Lastrapes (2002), analysed the response of house prices to money supply shocks. He employed a VAR framework and found that monetary shocks have real impacts on the housing market, affecting both prices and transactions volumes which rise in the short-run in response to positive money supply shocks.

Belke et al (2008) examine liquidity effects via asset inflation. Greiber and Setzer (2007) suggest that liquidity contributes to house price inflation and consider how money demand, Asset Inflation, and credit channels transmit liquidity effects.

Starting with the effects from housing price changes, as mentioned earlier, changes in house prices can affect changes in monetary aggregates. We consider the *money demand channel*. Here the wealth effects happen due to the existence of the credit channel. This has been defined as a housing collateral effect by Muellbauer (2007):

$$\Delta P_h \Rightarrow \Delta H_{\text{wealth}} \Rightarrow \Delta(\text{portfolio composition}) \Rightarrow \Delta \text{property demand} \Rightarrow \Delta \text{consumption}$$

In the substitution effect:

$$\Delta P_h \Rightarrow \text{change in the attractiveness of different assets} \Rightarrow \Delta \text{housing demand and} \Delta \text{money demand} \Rightarrow \Delta \% \text{property in portfolio}$$

In the transactions effect:

$$\Delta \text{transact}_h \Rightarrow \Delta(P_h + \text{numbT}) \Rightarrow \Delta M1(\text{demand for payments})$$

∨ higher in boom periods ⇒ need deposits and liquidity (M3 + M1)

In the collateral effect changes in house prices affect housing wealth and asset allocation within portfolios further impacting property demand and consumers expenditure. In the substitution effect, changes in house prices affect the relative attractiveness of different assets that impact housing demand, money demand and property portfolio weightings. Finally in the transactions effect, changes in the volume of transactions (numbT in the equation) change both house prices and future transactions numbers leading to changes in money demand.

In the *Asset Inflation channel*, changes in money supply lead to changes in inflation or asset prices:

$$\Delta M1 \Rightarrow \Delta \text{CPI or } \Delta \text{Asset Price}$$

Here, the final effect depends on price elasticity (of goods and assets). When goods are supply elastic, then the change in prices will tend to zero due to competition in the market. When supply elasticity of assets < 1 there will be positive asset price inflation as the housing market has restricted supply at least in the short run. Thus:

$$\Delta M1 \Rightarrow \Delta P_h \text{ depending on the elasticity value}^2,$$

$$\Delta P_h > 0 \text{ if } \epsilon_{H\text{supply}} < 1$$

In the *credit, or lending, channel*, changes in house prices lead to changes in lending. Higher collateral improves lending conditions and liquidity rises.

$$\Delta P_h \Rightarrow \Delta \text{collateral value} \Rightarrow \Delta \text{lending conditions} \Rightarrow \Delta \text{Debt} \Rightarrow \Delta \text{liquidity of housing wealth}$$

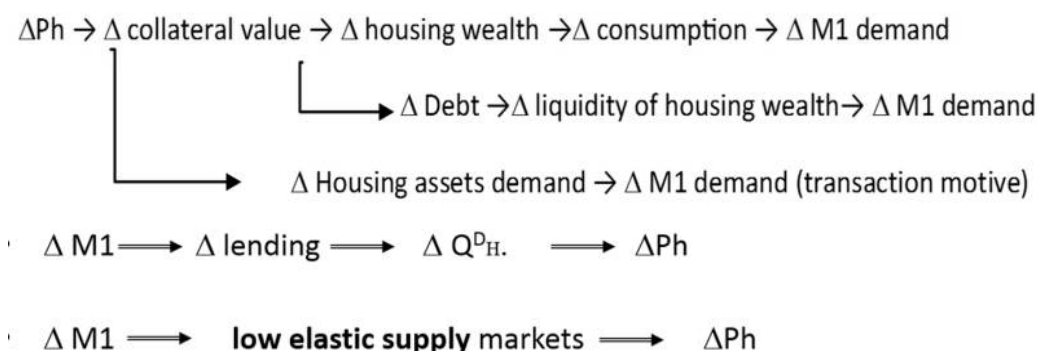
Further:

$$\Delta P_h \Rightarrow \Delta \text{collateral value} \Rightarrow \Delta \text{lending conditions} \Rightarrow \Delta \text{loans} \Rightarrow \Delta M1$$

As this channel has two directions it is identified as an *accelerator* (Greiber and Setzer, 2007).

Summarizing, the house price accelerator could be explained in Figure 3 representing the circular process where house prices affect monetary liquidity and vice versa.

Figure 3. Housing price circle



So changes in house prices have several effects causing changes in collateral values and changes in housing wealth, consumption and in M1 (money) demand. Changes

² It is understood that when goods or assets are supply elastic, any increase in liquidity has no effect on their prices due to the competition existing in the market. However, when they are price inelastic, any increase in monetary liquidity is transmitted to their prices.

in collateral value can also lead to changes in debt, changes in the liquidity of housing wealth and to changes in demand for money. Changing collateral value leads to changes in housing asset demand and demand for money via the transactions motive. In addition, Elbourne (2008) suggests that housing wealth affects consumption while Setzer et al (2010) suggest that housing wealth also determines money holdings.

4.- The model

We approach the *Asset Inflation channel* in two steps. In the first step we estimate the elasticity of supply (E_{sup}) using a supply equation based upon the current literature³.

$$\Delta H_t^s = f[E_{sup} * Ph_t, rir_t, R_t] + \mu_t \quad (1)$$

Where the supply elasticity is the estimated parameter of house prices, rir is real interest rates, and specific unobservable differences in each housing market (like developer structure, availability of land or regulation), represented by R_t ⁴.

In the second step a house price model is estimated through the *Asset Inflation channel* framework taking the following form:

³ The housing supply equations capture housing quantity responses to a house price change. It is considered that construction processes depend upon how builders respond to market signals (Arnott, 1987) with slow reactions due to the gap between building starts and completions, the lack of complete information, and financing requirements. The main factors determining new construction are material and labour costs, the cost of land and land availability (Goodman, 2005; Malpezzi & Vandel, 2002) and cost of finance (interest rates) within a market-oriented equilibrium framework (Blackley, 1999; Somerville, 1999; Di Pasquale, 1999; Mayer & Somerville, 2000). The literature tests the existence of different reactions depending on the phase in the economic cycle, with new demand putting pressure on prices during expansionary periods because increasing new building ‘takes time’ (DiPasquale, 1999; Meen, 2002; Topel & Rosen, 1988; and Quigley, 1997), and increasing vacancy and prices do not dramatically drop when demand decays. Such behaviour actually generates asymmetric responses across the housing market with elastic responses of house building during the former and inelastic ones in the latter (Glaeser, Gyourko & Sacks, 2005). In addition, the slope of the new supply curve changes over time (Pryce, 1999; Bramley, 1993; Malpezzi & Vandel, 2002; Goodman, 2005) and price-supply elasticities vary in the short run (small) relative to the long term (large) (De Leeuw & Ekanem, 1971; Olsen, 1987; Hanushek & Quigley, 1979; Meen, 2002; Blackley, 1999; Glaeser *et al.*, 2005; Quigley, 1997; Topel & Rosen, 1988; Malpezzi & MacLennan, 2001; Dipasquale & Wheaton, 1994; Goodman, 2005; Malpezzi & Vandell, 2002). The supply function is local and specific to different regions and metropolitan areas with elasticities changing at a spatial level as a result of the impact caused by territorial factors such as climate (Fergus, 1999) or spatial location (Goodman & Thibodeau, 1998; Saiz, 2007). Land control and zoning affects limit housing supply both directly and indirectly (Quigley *et al.*, 2008; Gyourko, Saiz & Summers, 2008; Barker, 2003) as well as the externalities in housing markets and the resulting regulations or housing policy effects (Murray, 1999; Malpezzi & Vandel, 2002; Whitehead, 2003). Decision-making process between builders and homeowners determine the degree of urbanization (Hanushek & Quigley, 1979); the barriers which lead to a quasi-monopoly competition (Green *et al.* 2005; Quigley, 2007) and the power owned by private or public actors operating in the market. Meanwhile there is substantial for UK supply elasticity (see Barker, 2004, Ball *et al.* 2012), and little for Spain with some papers, like Taltavull (2014), giving estimates of supply elasticity for Spanish regions.

⁴⁴ As construction costs are not fully available for both countries, they are not included into the model. We support this decision due to the low significance of results on such variables in previous work (Author names deleted, 2012) due to the extreme stable evolution during the time period analysed where they remained almost constant.

$$Ph^r_t = \Phi_3[M1^r_t, controls(Inc^r_t, Migr^r_t, inf l^r_t)] + \mu_t \quad (2)$$

Where the response of real house price to changes in liquidity (as a monetary policy tool) is measured, controlling for demand determinants⁵. Then, prices are regressed on the measure of liquidity in the economy M_1 and a set of control variables including fundamentals such as income (Inc), demographics (Migr) and inflation (infl). The model is run at national level for Spain and the UK. M_1 is used to measure monetary liquidity rather than M_3 because the latter includes the effect of the bank multiplier in deposits. M_1 contains the money in circulation (M_0) and the primary and liquid deposits whose changes constitute the first effect of liquidity changes in the economy, which is the effect this paper is seeking to investigate. The analysis ends in early 2014 in order to avoid the effect of new quantitative easing tools applied by the ECB.

- M_1 and M_3 evidence

Given the relevance of liquidity in our study, an analysis of its statistical characteristics is undertaken in order to examine the time evolution of liquidity and whether or not it might have caused some shocks during the period of investigation. In order to do this, we have analysed and compared both M_1 and M_3 in both countries and included the same variables for the whole EMU.

We have obtained data for liquidity in M_1 (basic money plus deposits) and M_3 (M_1 plus other liabilities) from three sources: Bank of England, Bank of Spain and the European Central Bank. The available period for liquidity data covers pre and post EMU periods, and data from 1980 are available at monthly and quarterly frequency.

In order to test the statistical properties of different measures of liquidity, unit-root tests have been conducted and have found that all series (for Spain and UK, both M_1 and M_3) are non-stationary and PP and ADF tests confirm that all are $I(1)$. Tests for non-stationary structural change is needed and two tests have been applied, the Zivot-Andrew (Z-A) and Perron Unit Roots with structural change test in order to identify breaks in the series' (Table 1). The null is rejected when p-value is lower than 5% and evidence from the data series reject the existence of a unit root with structural break. Results show how both tests reject the existence of structural change in the trend but not in intercept in the M_1 and M_3 series. Results are quite consistent and identify a break in the intercept (shift in the statistical series) during 2005, for Spain in M_1 but for Spain and UK in M_3 although only through the Z-A test. These suggest that the subsequent models need to control for such breaks. As M_1 is used, the model for Spain controls for a break in the intercept in 2005 with no other break points.

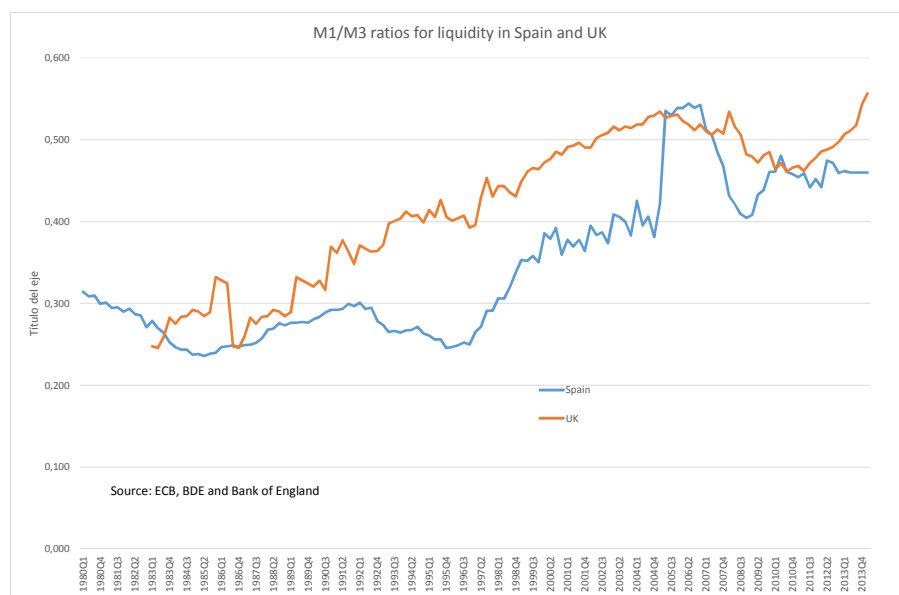
The lack of a structural break in trend could imply that the increase in liquidity follows a long term pattern during the period examined. This is consistent with the monetary theory of liquidity and the appearance of structural change in the

⁵ Equation (2) is, in fact, a way to represent an inverse demand equation, like contained in the housing demand literature, where prices depends on fundamentals (income, demographics and inflation).

intercept suggests that the sudden increase in primary liquidity happened during 2005.

Relationships between M_1 and M_3 are analysed using the ratio between them which could be assumed to be a measure of the multiplier as M_3 accounts for the different types of liabilities created based upon primary deposits. It can be seen that this ratio varies over time (Figure 4).

Figure 4: M1/M3 Ratios, UK and Spain



The larger value of this ratio the lower the propensity to keep money in cash or in short run deposits. The ratios suggest that in UK, households kept more liquid money than in Spain until the mid 2000's or, that bank activity retains a larger part of the money in circulation in form of medium or long term deposits, reducing liquidity. It also suggests some change in the propensity to hold liquid money.

The figure also suggests that both countries have experienced an increase in liquidity in households during the whole period until 2005 but with a stronger impact in Spain (which could have had a severe shock in liquidity) than in the UK.

5.- Data and econometric strategy

The data used are of quarterly frequency from 1995q1 (in estimation) to 2013q2. The variables are listed in Table 2 and the basic statistics in Table 3.

We test for unit roots and cointegration. In addition we test for presence of structural breaks in cointegrated relationships. Our empirical steps proceed with supply elasticity estimation where we also test for structural breaks and then re-estimate as necessary. In the price equation we include liquidity as an endogenous

determinant and control by supply elasticity. Again structural break tests are applied and re-estimation as necessary is undertaken.

The supply equation in logs is written as:

$$\Delta(stock)_t = \alpha + \beta_1 Ph_{t-1} + \beta_2 Rir_t + \mu_t \quad (3)$$

Where the change in stock is written as a semilog function of logged house prices and the real interest rate in levels. The house price log-log equation:

$$Ph_t | @ \varepsilon_{sup} = \alpha + \gamma_1 Inc_t + \gamma_2 Migr_t + \gamma_3 inf_t + \gamma_4 M_1 + \mu_t \quad (4)$$

Here supply elasticity is included along with liquidity captured by M_1 . The definition for M_1 includes money (notes and coins) in circulation plus primary deposits. This definition is selected because it is closer to the basis from which the credit creation process in the economy begins and, at the same time, is the closest measure of the amount of money households' hold to cover short term payments.

Following the previous definition of the money demand channel above, price increases can generate a need for greater liquidity through the transaction effect, this being the basis of the Greiber and Setzer (2007) housing price accelerator definition. This implies some endogeneity which must be considered in the model. Thus, a simultaneous equation, in addition to model (4), is calculated testing the following equation for M_1

$$M_{1t} = a + d_1 Inc_t + d_2 Migr_t + d_3 inf_t + d_4 (Ph_t | @ \varepsilon_{sup}) + \mu_t \quad (5)$$

Where money supply depends upon house price conditional on the elasticity of supply and a set of control variables; income, migration and inflation. Hence (4) and (5) together represent a system of simultaneous equations for price and liquidity.

The conventional modelling strategy is to find the functional form of (4) and (5), with tests for unit roots and cointegration to identify the dynamics of the data. Using the Johansen framework, we find the variables to be $I(1)$ which determine the VAR framework to estimate the model. Testing for cointegration, results cannot reject the null of no cointegration. Therefore we can express the models in (6) and (7). Thus:

$$\Delta Ph_t = \alpha + \phi_1^p [Ph_{t-1} + \gamma_{1p} Inc_{t-1} + \gamma_{2p} Migr_{t-1} + \gamma_{3p} M1_{t-1} + \gamma_{4p} inf_{t-1} + \gamma_{5p} Trend] + \sum_{j=1}^p \phi_j^p \Delta X_{t-j} + \phi_2^p @ \varepsilon_{sup,t} + \mu_t \quad (6)$$

$$\Delta M1_t = \alpha + \phi_1^{M1} [Ph_{t-1} + \gamma_{1M} Inc_{t-1} + \gamma_{2M} Migr_{t-1} + \gamma_{3M} M1_{t-1} + \gamma_{4M} inf_{t-1} + \gamma_{5M} Trend] + \sum_{j=1}^{M1} \phi_j^{M1} \Delta X_{t-j} + \phi_2^{M1} @ \varepsilon_{sup,t} + v_t \quad (7)$$

Where X_t is a matrix of endogenous variables including house prices, migration flows, real income and inflation; $@ \varepsilon_{supply}$ is defined as $Hs_{t-1} - \beta_1 Ph_{t-1} + \beta_2 rir_{t-1}$. This

represents the error from long-term supply equation which captures changes in supply conditioned on supply elasticity.

Rearranging the equations algebraically it can be found that:

$$\Delta Ph_t = \alpha + [\phi_1^p + \phi_2^p \varepsilon] Ph_{t-1} + \phi_1^p \gamma M1_{t-1} + \phi_1^p \gamma Z_i + \sum_{j=1}^p \phi_j^p \Delta X_{t-j} + \sum_{j=2}^p \phi_j^p E_i + \mu_t \quad (8)$$

$$\Delta M1_t = \alpha + [\phi_1^{M1} + \phi_2^{M1} \varepsilon] Ph_{t-1} + \phi_1^{M1} \gamma M1_{t-1} + \phi_1^{M1} \gamma Z_i + \sum_{j=1}^{M1} \phi_j^{M1} \Delta X_{t-j} + \sum_{j=2}^{M1} \phi_j^{M1} E_i + \varepsilon_t \quad (9)$$

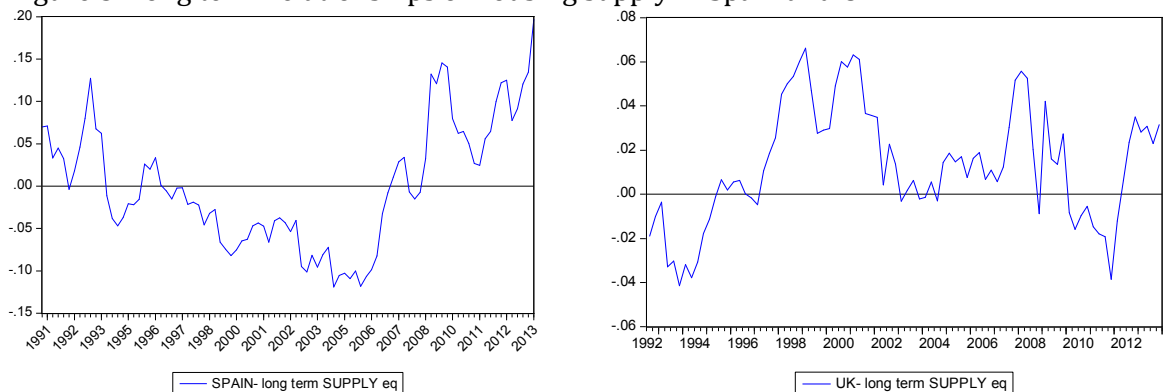
Where $\varepsilon = \varepsilon_{supp}$, Z_i is a matrix where the variables are in the long run relationships other than Ph and $M1$ E_i is a matrix of exogenous variables (such as changes in Stock and interest rates) and X_{it} is a matrix of all endogenous variables (house prices, migration flows, real income and inflation)

The expression shows how price effects in the long run depend upon the convergence parameter of both the LT relationship and the New supply relationship, while monetary supply effects depend on its convergence parameter.

6.- Results

The supply model identifies convergence in housing supply in both countries, and identifies a long term relationship between real house prices and interest rates and total supply. The measure of elasticity shows the expected sign and indicates that prices have a long term effect with permanent effects on supply in Spain and in the UK but more so in the former. The results suggest that changes in prices positively affect housing supply in Spain ($\varepsilon=0.115$) and in the UK ($\varepsilon=0.07$) permanently. The UK also experiences transitory effects of prices on supply suggesting a double price adjustment while in the case of Spain interest rates have transitory effects⁶. Long term relationships in both countries follow similar dynamics as can be seen in Figure 5 and the convergence to equilibrium is fast (convergence parameters are -0.028 for Spain and -0.002 for the UK).

Figure 5. Long term relationships of housing supply in Spain and UK



⁶ It is not unusual to find such results as the interest rates fell dramatically in Spain during the late nineties from 12% to 4% in just one year.

The evidence of the Asset Channel, in models (6) and (7) is found by estimating the equations through a Vector Error Correction (VECM) framework. Cointegration relationships are identified showing 2 relationships for the UK and for Spain. As the relationship capturing the reaction of supply to prices (elasticity) is $I(0)$ it is used as an exogenous variable in the model. There were no statistically significant structural breaks in the relationships in either country.

Table 5 presents the long run results for each country. Two cointegration relationships have been identified in each country, the first one being the house price dominated equation and the second governed by migration. Results in both cases are consistent with same signs except for the effects of inflation and elasticity. For Spain, the long term equation governed by prices (coint 1) suggests that prices (with a positive long term trend of 2%) are related to real income and monetary flows with a high elasticity of income (5.53) and a quasi-elastic relationship with monetary supply (0.96) both being strongly significant; the model also captures the long term relationship between inflation (in changes) and real house prices with a negative effect (-0.6). The equation governed by migration captures a long term causal relationship between population flows and liquidity, with an elastic reaction (1.07) and with a negative result for inflation with the same interpretation as before (-0.21). Note that following these results, the long term model for Spain does not capture a relationship between migration and real income suggesting that population is moving following work availability but not increases in income⁷.

In the case of the UK, income is one of the key variables in both long term equations with high elasticities as well (5.32 and 6.43 respectively)⁸. The results suggest that house prices react to changes in income and also migration moving across the country. The price equation is not sensitive to monetary liquidity in the long term and it is positively related with changes in inflation (0.1) which fuels house prices in the UK. The migration equation is related to liquidity as in the Spanish case, now with a higher elasticity (2.45). Following these results, monetary liquidity seems to be associated to demographic mobility and income although in the case of Spain, the causal relationship is shared through price evolution.

The evidence that monetary liquidity has short-term effects on house prices are shown through the error correction parameter (Table 5). Both senses of the Asset channel are evaluated (equations (8) and (9)) and their contribution to the short term equilibrium.

In the Spanish case, the price equation is the only one showing statistically significant parameters capturing how the system tends to the equilibrium. It suggests that only a '*price-adjustment-system*' exists⁹ (or any adjustment via prices)

⁷ This result is consistent in other Spanish models. See Taltavull and White, 2012

⁸ Note that the elasticities estimated in this equation are income elasticity of prices (and not income elasticity of demand as normally estimated), so as it represents the elasticity between income and price, which can be interpreted as a manner of substitution effect between two variables. The value is larger than those in the literature due to this paper including the supply elasticity in the demand equation as a control as well as liquidity. Both variables possibly capture the real income relationship in the models.

⁹ As the migration equation has a non statistically significant long term parameter, that is, it does not contribute to the LT equilibrium

for shocks in liquidity with bidirectional effects. That is, the long term coefficient is statistically significant, affecting the short run equilibrium in the two long term equations, explaining both house prices and monetary liquidity changes. The former shows a rapid convergence (-0.038) suggesting that long term price relationships rapidly restore house prices to equilibrium in the short term when a shock causes a deviation from the long term trend. The second long term equation is not statistically significant suggesting that migration-income-liquidity association does not contribute to the equilibrium. In the latter (the Spanish monetary liquidity reaction), in the long term the price equation convergence parameter is also statistically significant (-0.137) with a slower correction to the equilibrium than before, suggesting that causal effects exist between the liquidity and house prices, and that the house price long term relationship supports slow convergence to the equilibrium in liquidity when a shock modifies the liquidity trajectory out of the long term equilibrium. Then, the evidence suggests that prices and liquidity affect each other converging as Asset Channel predicts, but only through the price mechanism. The relevant role of the house price long run equation explaining changes in prices and liquidity suggests the existence of the housing accelerator effect in Spain.

In the UK model, the long term relationships are statistically significant and explain reversion to equilibrium only in the house prices long term equation (with convergence parameters of -0.114 and -0.029) but do not explain monetary liquidity changes. Both the price equation and migration equation play a significant role to support the reversion to house price equilibrium following a shock moving it from its long term trajectory. As liquidity is statistically significant in the migration equation with a large parameter, the convergence highlighted by the two parameters in the two equations would signify that liquidity has strong effects on house price correction in the short run. However, the model does not capture similar influences with changes in liquidity suggesting that the relationship between house prices and liquidity in the UK has one direction and a house price accelerator effect does not exist.

Regarding the price effect as the house price parameters obtained in (7) and (8), the model supports the previous interpretation suggesting rapid convergence in prices in Spain compared to the UK, low convergence in Spanish liquidity and no convergence in UK liquidity.

The results showing the short run corrections are in Table 6. In the Spanish model, house price changes are quite fully explained by the long term relationship and only a price influence remains from the past (4 lags, 0.404) to explain changes in house prices. Short run changes in monetary liquidity are, on the other hand, receiving influences from various variables, such as real income changes (-1.46, 1 lag), inflation (positive in two lags, 0.052 and 0.036) and its own dynamic. Supply elasticity is only statistically significant affecting changes in monetary liquidity and the parameter (-0.793) could be interpreted as a 1% increase in supply reduces liquidity growth by 0.793% which is significant. However, that effect has no long term impact on house price change nor on monetary liquidity change as the convergence parameter of cointegration equation 2 is not statistically significant.

In the case of the UK, the house price change equation shows dependence on its own dynamics as well as migration (1 and 5 lags) converging (-0.313 and 0.102), real income (0.102) and liquidity (negative, -1.302) suggesting that an increase in migration and liquidity in the very short term reduces the house price growth. In this case, the liquidity equation does not have a short term relationship with the fundamental variables, and only shows its own dynamics and the existing relationship with inflation.

The explanatory power is large, 59.1% and 59.2% of the house price evolution, while it is 43.2% and 23.7% for the liquidity equations.

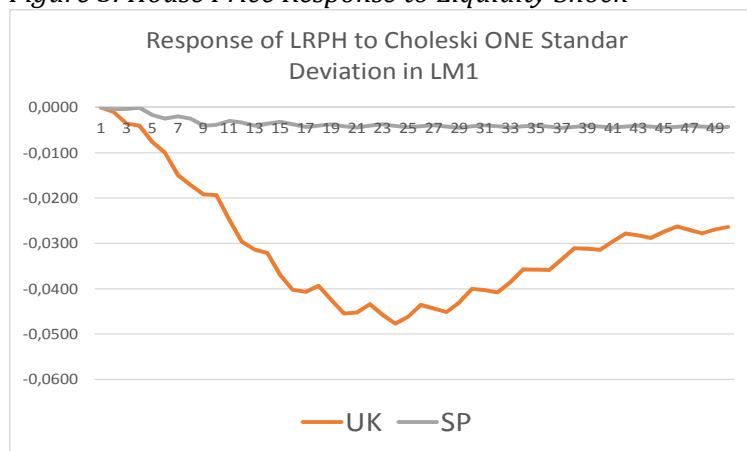
Next we now examine the Choleski impulse responses for changes in house prices and liquidity on each other for each country. These are shown in figures 5 and 6 below. Both figures suggest that the fall in house price with permanent effect happening from two years ago. A shock in monetary variables generates a negative reaction in house prices that is stronger in the UK than in Spain. Figure 5 shows how the UK experiences a house price contraction up to 25 lags that reverses slowly to equilibrium. However, an increase in house prices generates an increase in monetary liquidity (Figure 6) with permanent effects in both countries. In Spain, the response of house prices to changes in liquidity is very little and they do not react to the shock. In the UK case, the increase in liquidity falls to lag 9 (also in Spain) then afterwards, increasing liquidity with permanent effects in UK but with diminishing permanent effects in Spain.

The negative reaction could be explained because the nature of liquidity used here (M1 and not M3) with less savings components suggests that liquidity is converted into longer deposits quickly. If so, and liquidity serves to buy houses, the evidence suggests that the buyers have market power during the observed period (buyers-market) and can reduce the market price. In the UK, house prices react by falling when liquidity rises, which could reflect how UK buyers bargain more than is usual in the Spanish market.

Results can also capture the UK market evolution during a distressed period when house prices fall and liquidity rises. Such effects are not captured in Spain due to the period covered, as the quantitative easing policy was not at that stage applied by the ECB. However, from the first Choleski Impulse response exercise in both economies, the lower the basic liquidity, the higher the house prices.

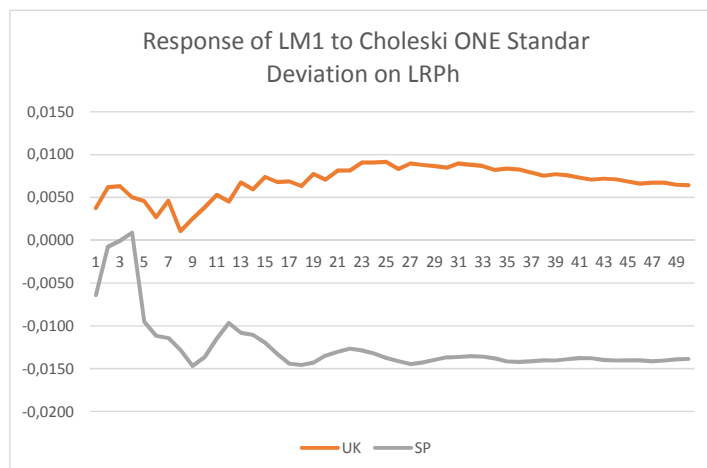
The analysis suggests that a causal relationship exists in both countries through which an expansionary monetary policy is related to falling housing prices which could be interpreted as the ability of the former to explain the fall in housing prices. This is strongly true in the UK but just weakly true in the Spanish housing market.

Figure 5: House Price Response to Liquidity Shock



We test in the opposite direction in figure 6. In the case of a house price shock to liquidity, results are quite different by country. In this scenario, there is a positive response in liquidity to a house price shock in the case of the UK with permanent effects. This could be understood as evidence of larger house prices generating more primary liquidity as the transaction channel suggests.

Figure 6: Liquidity Response to House Price Shock



In Spain however the response is negative suggesting that an unexpected shock in house prices would reduce monetary liquidity with permanent effects. Results are consistent with the interpretation above.

7.- Discussion and conclusions

This paper analyses the role of liquidity shocks on housing prices in Spain and the UK. It discusses the transmission channels serving as a vehicle to bring influences of monetary policy interventions on housing prices and give empirical evidence of the effects in both economies submitted to different monetary policies plans. It

examines how the Asset price channel transmit changes in M1 to house prices in Spain and the UK.

The paper uses VAR methodology to test the Asset Inflation Channel for the aggregate housing markets. The paper uses VAR and Error Correction models to test the Asset Inflation channel in two steps. In the first step, the supply elasticity is estimated in the long term relationship between house prices and supply. The second step estimates a VECM to explain house prices dynamics conditioned on supply reactions. The latter is defined as a long term inverse demand model where house prices are controlled by fundamentals in each market, including income, migration flows and inflation. Choleski impulse responses identify the reactions to a shock in monetary liquidity.

Results give empirical evidence on how an increase in basic liquidity (M1) is transmitted to house prices. The supply model identifies convergence in housing supply suggesting that both economies fulfil the supply mechanism providing quick return to the equilibrium and maintain their long term relationship between stock and house prices. Long term elasticity in Spain is greater than in the UK suggesting larger reactions in housing supply to price changes; additionally, the UK exhibits short term effects on prices while the model in Spain seems to identify a double price adjustment in the latter.

The channel model identifies two ways through which liquidity impacts house prices: the price and migration equations. The existing liquidity affects changes in prices in Spain through both while only through one (the migration equation) in the UK. In the Spanish case, liquidity has an elasticity close to one in both relationships suggesting that changes in liquidity have double effects on both the mechanism affecting house price changes and in relation to income and migration. In the UK, liquidity is only statistically significant in the second relationship (with income and migration) but with a very large elasticity (2.45) indicating that the effect of liquidity is through income and the labour market mechanism and not directly via housing prices.

How those mechanisms affect the short run house price equilibrium is also different between the economies. Cointegration parameters clearly establish a double impact on house price changes in Spain coming from both relationships defining a fast convergence to equilibrium: the long term price equation is the only one showing statistically significant parameter in the VECM for Spain suggesting a 'price-adjustment-system' or any adjustment via prices of any shock in liquidity, in both directions, liquidity and housing prices. The evidence suggests that prices and liquidity affect each other as the Asset Channel implies, and gives empirical evidence of the existence of the housing accelerator effect in Spain.

In the UK the effect to restore equilibrium occurs in house prices but not in the monetary liquidity equation. Both the price equation and migration equation play a significant role in support of the reversion to house price equilibrium following a shock moving it from its long term trajectory. The model captures that liquidity has strong effects on house price corrections in the short run but only in one direction,

rejecting the hypothesis of the existence of a house price accelerator affecting liquidity in the UK.

The model results support the idea of long term relationships between monetary liquidity and house prices in Spain, with rapid convergence to the equilibrium, which suggests house price evolution could be forecast following liquidity evolution and an accelerator could be expected with prices and liquidity fuelling each other. However, this is not the case in UK, where liquidity affects house price changes from several mechanisms including short term effects, but there is not reverse influence showing that the Asset channel in UK is uni-directional.

In addition, the simulations support the evidence with two countries' data capturing the market reactions and showing the differences between the two housing mechanism. The models reflect the distinct monetary mechanism's effect in both countries, one (Spain) being in the euro area and having a common interbank market with a supposed larger area for liquidity; while the UK is submitted to liquidity control in a smaller monetary area. For Spain, the increase in liquidity volatility has a smaller effect as such liquidity could move across the euro area while in the UK this is not the case. In the case of the contrary (increases in house prices affecting liquidity) the transaction channel effect supports the larger reaction forecasted in Spain rather than in the UK¹⁰.

¹⁰ We would thank to an anonymous referee for identifying this effect.

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TABLES

Table 1: Structural breaks in Liquidity time series.

| M1 | | | | | | | |
|----------------------|--|---------------|----------|---------------|--------|---------------------|----------|
| Period 1990.1-2013.4 | | Intercept | | Trend | | intercept and trend | |
| 4 lags | | Zivot-Andrews | Perron | Zivot-Andrews | Perron | Zivot-Andrews | Perron |
| Spain | | -7,5*** | -7.82*** | -2,51 | -2.35 | -11.3*** | -11.5*** |
| break point | | 2005Q2 | 2005Q1 | 2009q4 | 2009Q4 | 2005q2 | 2005Q1 |
| UK | | -2,6 | -2.67 | -2,64 | -2.71 | -2,76 | -2.74 |
| break point | | 2005q1 | 2004Q4 | 1999Q1 | 2001Q2 | 2004q1 | 2003Q4 |
| M3 | | | | | | | |
| Spain | | -43.44*** | -3.37 | -2.61 | -2.43 | -3.28*** | -3.19 |
| break point | | 2004q4 | 2004q3 | 2009q4 | 1995Q2 | 2006q2 | 2006Q2 |
| UK | | -3,46*** | -3.49 | -1.98 | -2.01 | -2,07 | -2.07 |
| break point | | 2006q1 | 2005q4 | 1999q1 | 1997Q4 | 1997q3 | 1997q2 |

Table 2: Data Definitions and Sources

| Variables | Definition | Source | Period |
|-------------------------|--|-------------------------------------|---------------------------------|
| Period 1990.1-2013.4 | | | |
| IRPH | Real House prices (logs) | Ministry of Fomento- Spain | 1991q1-2014q1 (1989q1 Spain) |
| | | HBOS | 1983q1-2012q1 |
| LMIG | Migration. Net increase on population (logs) | INE. Spain | 1988q1-2013q4 |
| | | Government Statistics - UK | 1983q1-2009q2 |
| LRINC | Income (logs) | INE. Spain | 1990Q1-2014Q1 |
| | | UK | 1990q4-2012q4 |
| RIR | Real mortgage interest rate | Bank of Spain | 1990q1-2014q1 |
| | | Bank of England | 1983q1-2014q1 |
| INF | Inflation | INE. Spain | 1992q1-2014q1 |
| | | Government Statistics - UK | 1983q1-2014q1 |
| LRMORTG | Flow of real mortgage credits to finance housing purchases (logs) | INE. Spain | 1990Q1-2014Q1 |
| | | Council of Mortgage Lenders - UK | 1983q1-2013q1 |
| LM1 | Liquidity in the economy-M1 (logs) | Bank of Spain | 1990q1-2013Q4 |
| | | Bank of England | 1983q1-2013Q4 |

Table 3. Descriptive statistics

| | | Mean | Median | Maximum | Minimum | Std. Dev. | Skewness | Kurtosis | Observations |
|----------|----|-------|--------|---------|---------|--------------|----------|----------|--------------|
| LRPH | UK | 6,58 | 6,54 | 6,96 | 6,28 | 0,21 | 0,35 | 1,89 | 96 |
| | SP | 7,23 | 7,18 | 7,69 | 6,89 | 0,28 | 0,33 | 1,57 | 97 |
| LMIG | UK | 4,13 | 4,04 | 4,63 | 3,55 | 0,38 | 0,05 | 1,59 | 58 |
| | SP | 12,70 | 12,72 | 13,59 | 11,03 | 0,60 | -0,27 | 2,03 | 84 |
| LRINC | UK | 9,22 | 9,21 | 9,31 | 9,13 | 0,04 | 0,12 | 2,41 | 78 |
| | SP | 7,47 | 7,46 | 7,61 | 7,35 | 0,05 | 0,20 | 2,48 | 97 |
| RIRM | UK | 4,36 | 4,71 | 9,06 | -1,17 | 2,06 | -0,60 | 2,95 | 97 |
| | SP | 3,62 | 2,42 | 11,26 | -0,53 | 3,30 | 0,84 | 2,60 | 97 |
| INF | UK | 2,68 | 2,30 | 8,38 | 0,63 | 1,74 | 1,67 | 5,31 | 97 |
| | SP | 3,31 | 3,23 | 6,98 | -1,02 | 1,66 | -0,07 | 3,15 | 97 |
| LRMORT | UK | 17,26 | 17,22 | 17,93 | 16,36 | 0,32 | -0,61 | 3,54 | 85 |
| | SP | 16,33 | 16,30 | 17,84 | 15,10 | 0,82 | 0,24 | 1,89 | 96 |
| LM1 | UK | 13,15 | 13,20 | 14,09 | 12,10 | 0,64 | -0,19 | 1,65 | 93 |
| | SP | 12,36 | 12,26 | 13,19 | 11,49 | 0,65 | 0,08 | 1,34 | 93 |
| D(Stock) | SP | 97,47 | 91,48 | 208,55 | 12,99 | 46,10 | 0,21 | 2,11 | 95 |
| | UK | 47,33 | 48,00 | 62,00 | 32,00 | 6,99 | 0,22 | 2,96 | 85 |

Table 4: Model Results – Supply Equation

| Period 1990.1-2013.4 | SPAIN | UK |
|--|----------------------|-----------------------|
| Dep variable | $\Delta(Lstock)$ | $\Delta(Lstock)$ |
| Long term | | |
| Lstock(-1) | 1.00 | 1.00 |
| LRPh (-1) | -0.115*** | -0.071*** |
| rir_m(-1) | 0.018*** | 0.021*** |
| Trend | 0.002*** | -- |
| C | -2.14 | -9.43 |
| Error correction results | | |
| Short run Convergence parameter | -0.028*** | -0.002*** |
| <i>t-stat</i> | (-4.26) | (-3.52) |
| <i>Lag of equilibrium</i> | 5 | 5 |
| $\Delta(Lstock (-1))$ | | |
| $\Delta(Lstock (-2))$ | | 0.331*** |
| $\Delta(Lstock (-4))$ | | 0.583*** |
| $\Delta(LrPh (-2))$ | | 0.0014*** |
| $\Delta(rir_mort (-3))$ | 0.0005*** | --- |
| $\Delta(rir_mort (-4))$ | 0.0003*** | -- |
| C | 0.0025*** | --- |
| Ad R2 | 0.761 | 0.86 |
| Σe^2 | 0.00008 | 0.000 |
| F | 17.711 | 36.43 |
| Log Likelihood | 501.69 | 672.30 |
| Cointegration tests (Johansen) | | |
| None.....Trace Stat/0.05 critical value | 62.86/42.91 p<0.001 | 46.92/29.79, p<0.001 |
| NoneMax-Eigen Stat/0.05 critical value | 39.51/25.82, p<0.001 | 39.136/21.13, p<0.001 |
| At most 1Trace Stat/0.05 critical value | 23.35/25.87, p=0.362 | 7.79/15.49, p=0.488 |
| At most 1Max-Eigen Stat/0.05 critical value | 15.37/19.38, p=0.423 | 4.35/14.26, p=0.81 |

*** p-value<0.01

** p-value <0.05

Table 5: Asset Channel model. Long Term Results

| Period 1990.1-2013.4 | SPAIN | | UK | |
|-------------------------------|----------------------------|----------------------------------|----------------------------|----------------------------------|
| | Coint 1 | Coint 2 | Coint 1 | Coint 2 |
| Endogenous | γ_{1ip} | γ_{2ip} | γ_{1iM} | γ_{2iM} |
| RPh _{t-1} | 1.00 | 0.00 | 1.00 | 0.00 |
| Mig _{t-1} | 0.00 | 1.00 | 0.00 | 1.00 |
| RInc _{t-1} | -5.53*** | -1.53 | -5.32*** | -6.43*** |
| <i>t-stat</i> | [-4.797] | [-1.433] | [-11.96] | [-3.467] |
| M1 _{t-1} | -0.96*** | -1.07*** | -0.12 | -2.45*** |
| <i>t-stat</i> | [-7.134] | [-8.587] | [-0.655] | [-3.284] |
| $\Delta(\text{Infl})_{t-1}$ | 0.60*** | 0.21*** | -0.10** | 0.23 |
| <i>t-stat</i> | [6.835] | [2.568] | [-2.182] | [1.151] |
| <i>Trend</i> | 0.02*** | 0.01 | -0.004 | 0.041 |
| <i>t-stat</i> | [4.814] | [1.878] | | |
| C | 44.98 | 11.52 | 39.53 | 85.17 |
| Error correction parameter | | | | |
| Equation (dep var) | $\Delta(\text{ph})$ | $\Delta(\text{M1})$ | $\Delta(\text{ph})$ | $\Delta(\text{M1})$ |
| | ϕ_1^p | ϕ_1^{M1} | ϕ_1^p | ϕ_1^{M1} |
| Convergence 1 | -0.038*** | -0.137*** | -0.114*** | 0.033 |
| <i>t-stat</i> | [-2.35627] | [-3.07689] | [-3.15084] | [0.69946] |
| Convergence 2 | 0.028 | 0.016 | -0.029** | 0.038 |
| <i>t-stat</i> | [1.29213] | [0.26641] | [-2.02227] | [2.01025] |
| Exogenous | φ_2^p | φ_2^{M1} | φ_2^p | φ_2^{M1} |
| $\varepsilon_{\text{supply}}$ | -0.176 | -0.793*** | -0.080 | 0.384*** |
| <i>t-stat</i> | [-1.288] | [-2.136] | [-0.595] | [2.208] |
| | RPh | M1 | RPh | M1 |
| | $[\phi_1^p + \varphi_2^p]$ | $[\phi_1^{M1} + \varphi_2^{M1}]$ | $[\phi_1^p + \varphi_2^p]$ | $[\phi_1^{M1} + \varphi_2^{M1}]$ |
| <i>Price Effect</i> | -0,03849 | -0,92943 | -0,11439 | 0,38354 |

All variables are en logs but inflation. In red. parameters non statistically significant

*** $p\text{-value} < 0.01$. ** $p\text{-value} < 0.05$, * $p\text{-value} < 0.1$

*Table 6: Error Correction Model Results
(only statistically significant results)*

| | SPAIN | | UK | |
|-----------------------------|--------------|--------------|--------------|--------------|
| Dependent variables | $\Delta(ph)$ | $\Delta(M1)$ | $\Delta(ph)$ | $\Delta(M1)$ |
| Lags to equilibrium | 4 | | 6 | |
| <i>Short run parameters</i> | | | | |
| $\Delta(RPh\ t-1)$ | | | 0.364*** | |
| <i>t-stat</i> | | | [2.79815] | |
| $\Delta(RPh\ t-4)$ | 0.404*** | | | |
| <i>t-stat</i> | [3.70303] | | | |
| $\Delta(RPh\ t-5)$ | | | -0.313** | |
| <i>t-stat</i> | | | [-2.04872] | |
| $\Delta(Mig\ t-1)$ | | | -0.313** | |
| <i>t-stat</i> | | | [-2.04872] | |
| $\Delta(Mig\ t-5)$ | | | 0.102*** | |
| <i>t-stat</i> | | | [2.60769] | |
| $\Delta(RInc\ t-1)$ | | -1.464** | 0.102*** | |
| <i>t-stat</i> | | [-2.17454] | [2.60769] | |
| $\Delta(M1\ t-1)$ | | -0.473*** | | |
| <i>t-stat</i> | | [-3.62198] | | |
| $\Delta(M1\ t-2)$ | | -0.426*** | | |
| <i>t-stat</i> | | [-3.23138] | | |
| $\Delta(M1\ t-4)$ | | | -1.302*** | -1.304** |
| <i>t-stat</i> | | | [-2.69400] | [-2.09321] |
| $\Delta^2(infl\ t-1)$ | | 0.052*** | | |
| <i>t-stat</i> | | [2.71357] | | |
| $\Delta^2(infl\ t-2)$ | | 0.036*** | | |
| <i>t-stat</i> | | [2.48750] | | |
| $\Delta^2(infl\ t-3)$ | | | | -0.292* |
| <i>t-stat</i> | | | | [-1.99266] |
| $\Delta^2(infl\ t-4)$ | | | | -0.298** |
| <i>t-stat</i> | | | | [-2.01119] |
| C | | 0.025*** | | |
| <i>t-stat</i> | | [3.77247] | | |
| Trend | | | | -0.0004*** |
| | | | | [-2.63053] |
| Adj R ² | 0.591 | 0.432 | 0.592 | 0.237 |
| Σe^2 | 0.015 | 0.108 | 0.018 | 0.029 |
| F-statistic | 6.182 | 3.730 | 4.588 | 1.766 |
| Log likelihood | 254.492 | 167.506 | 239.604 | 218.045 |

*** p -value<0.01, ** p -value<0.05, * p -value<0.1